ADDRESS

TO THE

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

DELIVERED BY THE PRESIDENT,

JOHN PHILLIPS,

M. A. OXON.; LL. D. DUBLIN; F. R. S.; F. G. S.; ETC.

IN THE

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ADDRESS.

ASSEMBLED for the third time in this busy centre of industrious England, amid the roar of engines and the clang of hammers, where the strongest powers of nature are trained to work in the fairy chains of art, how softly falls upon the ear the accent of Science, the friend of that art, and the guide of that industry! Here, where Priestley analysed the air, and Watt obtained the mastery over steam, it well becomes the students of nature to gather round the standard which they carried so far into the fields of knowledge. And when, on other occasions, we meet in quiet colleges and Academic halls, how gladly welcome is the union of fresh discoveries and new inventions with the solid and venerable truths which are there treasured and taught. Long may such union last; the fair alliance of cultivated thought and practical skill; for by it labour is dignified and science fertilized, and the condition of human society exalted!

Through this happy union of science and art, the young life of the British Association,—one-third of a century,—has been illustrated by discoveries and enriched by useful inventions in a degree never surpassed. How else could we have gained that knowledge of the laws of nature which has added to the working strength of a thousand millions of men the mightier power of steam[a], extracted from the buried ruins of primeval forests their treasured elements of heat and light and colour, and brought under the control of the human finger, and converted into a messenger of man's gentlest thoughts, the dangerous mystery of the lightning[b]?

How many questions have we asked—not always in vain—regarding the constitution of the Earth, its history as a planet, its place in creation;—now probing with sharpened eyes the peopled space around—peopled with a thousand times ten thousand stars;—now floating above the clouds in colder and clearer air;—now traversing the polar ice—the desert sand—the virgin forest—the unconquered mountain;—now sounding the depths of the ocean, or diving into the dark places of the earth. Everywhere curiosity, everywhere discovery, everywhere enjoyment, everywhere some useful and therefore some worthy result.

[a] The quantity of coal dug in Great Britain in the year 1864 appears by the returns of Mr. R. Hunt to have been 92,787,873 tons. This would yield, if employed in steam engines of good construction, an amount of available force about equal to that of the whole human race. But in the combustion of coal not less than ten times this amount of force is actually set free—nine-tenths being at present unavailable, according to the statement of Sir William Armstrong, in his Address to the Meeting at Newcastle in 1863.

[b] The definite magnetic effect of an electrical current was the discovery of Oersted in 1819; Cooke and Wheatstone's patent for an Electric Telegraph is dated in 1837; the first message across the Atlantic was delivered in 1858. Tantæ molis erat.

Life in every form, of every grade, in every stage; man in every clime and under all conditions; the life that now surrounds us, and that which has passed away;—these subjects of high contemplation have been examined often, if not always, in the spirit of that philosophy which is slowly raising, on a broad security of observed facts, sure inductions, and repeated experiments, the steady columns of the temple of physical truth.

Few of the great branches of the study of nature on which modern philosophy is intent were left unconsidered in the schools of Athens; hardly one of them was or indeed could be made the subject of accurate experiment. The precious instruments of exact research—the measures of time, and space, and force, and motion—are of very modern date. If instead of the few lenses and mirrors of which traces appear in Greek and Roman writers[c], there had been even the first Galilean or the smallest Newtonian telescope in the hands of Hipparchus, Eratosthenes, or Ptolemy, would it have been left to their remote successors to be still struggling with the elements of physical astronomy, and waiting with impatience till another quarter of a century shall have rolled away and given us one more good chance of measuring the distance of the Sun by the Transit of Venus? Had

[c] The effect of lenses or globes of glass or crystal (ὕαλος) in collecting the solar rays to a point are familiarly referred to by Aristophanes in the Nubes, 766; and the ornamental use of convex and concave reflectors is known by the curious discussions in the IVth Book of Lucretius.

such instruments as Wheatstone's Chronoscope been invented, would it have been left to Foucault to condense into his own apartment an experimental proof of the velocity of light, and within a tract of thirty feet to determine the rate of its movement through all the vast planetary space of millions and thousands of millions of miles, more exactly than had been inferred by astronomers from observations of the satellites of Jupiter[d]? By this experiment the velocity of light appears to be less, sensibly less, than was previously admitted; and this conclusion is of the highest interest. For, as by assuming too long a radius for the orbit of Jupiter the calculated rate of light-movement was too great; so now by employing the more exact rate and the same measures of time we can correct the estimated distance of Jupiter and all the other planets from the sun. We have in fact a really independent measure of planetary space; and it concurs with observations of the parallax of Mars, in requiring a considerable reduction of the assumed diameters of the planetary paths. The distance of the earth from the sun must be reduced from above ninety-five to less than ninety-three millions of miles, and by this scale the other space-

[d] Fizeau performed experiments on the velocity of light between Suresnes and the Butte Montmartre, by means of the oxy-hydrogen light, reflected back in its own path. The space was 28,324 ft. Engl. Twice this distance was traversed in $\frac{1}{18000}$ of a second $=$ 167,528 geogr. miles in a second. From observations of Jupiter's Satellites Delambre inferred 167,976 miles, Struve 166,096. The experiment of M. Foucault gives 298,000,000 metres $=$ 160,920 geogr. miles.

measures of the solar system, excepting the diameter of the earth and the distance and diameter of the moon, may be corrected [e].

The light and heat which are emitted from the sun reach the earth without great diminution by the absorptive action of the atmosphere; but the waste of heat from the surface of our planet through radiation into space is prevented, or rather lessened by this same atmosphere. Many transparent bodies admit freely heat-rays derived from a source of high temperature, but stop the rays which emanate from bodies only slightly warmed. The atmosphere possesses this quality in a remarkable degree, and owes it to the presence of diffused water and vapour; a fact which Dr. Tyndall has placed in the clear light of complete and varied experiment [f]. The application of this truth to the history of the earth and of the other planets is obvious. The vaporous atmosphere acts like warm clothing to the earth. By an augmented quantity of vapour dissolved, and water

[e] Estimates of the earth's distance from the sun have varied much. Cassini and Flamsteed, using observations of the parallax of Mars, ascribe to it ten or eleven thousand diameters of the earth =79 or 89 millions of miles. Huyghens estimated it at twelve thousand=95 millions of miles. In 1745, Buffon reported it as the common opinion of astronomers at 30 millions of leagues (Fr.) =90 millions miles (Engl.), but after the transit of Venus in 1769, he allowed 33 millions. Such was the effect of that now supposed erroneous experiment on the opinions of astronomers. (Epoques de la Nature.)

[f] Proc. of Roy. Soc. 1861. The Rumford Medal was adjudged to Dr. Tyndall in 1864.

suspended in the air, the waste of surface-heat of the earth would be more impeded; the soil, the water, and the lower parts of the atmosphere would grow warmer; the climates would be more equalized; the general conditions more like what has been supposed to be the state of land, sea, and air during the geological period of the Coal-measures.

Such an augmentation of the watery constituents in the atmosphere would be a natural consequence of that greater flow of heat from the interior, which by many geologists, mathematicians, and chemists is supposed to have happened in the earlier periods of the history of the Earth.

By the same considerations we may understand how the planet Mars, which receives not half so much heat from the sun[g] as the earth does, may yet enjoy, as in fact it seems to enjoy, nearly a similar climate, with snows alternately gathering on one or the other of its poles, and spreading over large spaces around, but not, apparently, beyond the latitude of 50° or 40°; the equatorial band of 30° or 40° North or South being always free from snow-masses bright enough and large enough to catch the eye of the observer. Mars may, therefore, be inhabited, and we may see in the present state of this inquiry reason to pause before refusing the probability of any life to Jupiter and even more distant planets.

The history of suns and planets is in truth the

[g] The proportion is about $\frac{100}{231}$ according to the received measure of the mean distance.

history of the effects of light and heat manifested in them, or emanating from them. Nothing in the universe escapes their influence; no part of space is too distant to be penetrated by their energy; no kind of matter is able to resist their transforming agency. Many if not all the special forces which act in the particles of matter are found to be reducible into the general form of heat; as this is convertible and practically is converted into proportionate measures of special energy. Under this comprehensive idea of convertibility of force, familiar to us now by the researches of Joule[h], the reasonings of Grove[i] and Helmholtz, and the theorems of Rankine[k], it has been attempted by Mayer, Waterston, and Thomson[l] to assign a cause for the maintenance of the heat-giving power of the sun in the appulse of showers of aërolites and small masses of matter, and the extinction of their motion on the surface of the luminary. By calculations of the same order, depending on the rate of radiation of heat into space, the past antiquity of the earth and the future duration of sunshine have been expressed in thousands or millions of centuries[m]. In like manner the

[h] Phil. Mag. 1843; Reports of the British Association, 1845; Trans. of the Royal Society, 1850.

[i] Grove on the Correlation of Physical Forces, 1846.

[k] Rankine, Trans. of the Royal Society of Edinburgh, 1850–1; Phil. Trans. 1854.

[l] Communication to the Royal Society of Edinburgh, 1854.

[m] Professor Thomson assigns to the sun's heat, supposing it to be maintained by the appulse of masses of matter, a limit of

physical changes on the sun's disk, by which portions of his darkly heated body become visible through the luminous photosphere, have been connected, if not distinctly as a cause, certainly as a coincident phænomenon, with particular magnetic disturbances on the surface of the earth; the solar spots and the magnetic deflections concurring in periods of maxima and minima of 10 or 11 years' duration. Thus even these aberrant phænomena become part of that amazing system of periodical variation which Sabine and his fellow-labourers, British, French, German, Russian, and American, have established by contemporaneous observation over a large part of the globe[n].

With every change in the aspect and position of the sun, with every alteration in the place and attitude of the moon, with every passing hour, the magnetism of the earth submits to regular and calculable deviation. Through the substance of the ground, and across the world of waters, Nature, ever the

300,000 years; and to the period of cooling of the earth from universal fusion to its actual state, 98,000,000 years. These are the lowest estimates sanctioned by any mathematician.

[n] Among the interesting researches which have been undertaken on the subject of the spots, may be mentioned those of Wolf (Comptes rendus, 1859), who finds the number and periodicity of the spots to be dependent on the position of Venus, the Earth, Jupiter, and Saturn. Stewart has made a special study of the relation of the spots to the path of Venus (Proc. of the Roy. Soc. 1864); and Chacornac is now engaged in unfolding his conception of the spots as the visible effect of volcanic excitement. The peculiar features of the solar surface are under examination by these and other good observers; such as Dawes, Nasmyth, Secchi, Stone, Fletcher, and Lockyer.

beneficent guide to Science, has conveyed her messages and executed her purposes, by the electric current, before the discovery of Oersted and the magical inventions of Wheatstone revealed the secret of her work.

Even radiant light in the language of the new Philosophy is conceived of by Maxwell[o], as a form of electro-magnetic motion. And thus the imponderable, all-pervading powers, by which molecular energy is excited and exchanged, are gathered into the one idea of restless activity among the particles of matter :—

... æterno percita motu :

ever-moving and being moved, elements of a system of perpetual change in every part, and constant preservation of the whole.

What message comes to us with the light which springs from the distant stars, and shoots through the depths of space to fall upon the Earth after tens, or hundreds, or thousands of years ? It is a message from the very birthplace of light, and tells us what are the elementary substances which have influenced the refraction of the ray. Spectral analysis, that new and powerful instrument of chemical research for which we are indebted to Kirchhoff, has been taught by our countrymen to scrutinize not only planets and stars, but even to reveal the constitution of the

[o] Proc. of Roy. Soc. 1864. The elder Herschel appears to have regarded the light of the sun and of the fixed stars as perhaps the effect of an electro-magnetic process—a perpetual aurora.

nebulæ, those mysterious masses out of which it has been thought new suns and planets might be evolved—nursing-mothers of the stars. For a time, indeed, the resolution of some nebulæ, by the giant mirror of Lord Rosse, afforded ground for opposing the speculation of Herschel and the reasoning of Laplace, which required for their very starting-point the admission of the existence of thin gaseous expansions, with or without points or centres of incipient condensation, with or without marks of internal movement. The latest results, however, of spectral analysis of stars and nebulæ by Mr. Huggins and Professor W. A. Miller, have fairly restored the balance. The nebulæ are indeed found to have in some instances stellar points, but they are not stars; the whole resembles an enormous mass of luminous gas, with an interrupted spectrum of three lines, probably agreeing with nitrogen, hydrogen, and a substance at present unknown[p]. Stars tested by the same accurate hands are found to have a constitution like that of our own Sun, and, like it, to shew the presence of several terrestrial elements—as sodium, magnesium, iron, and very often hydrogen. While in the Moon and Venus no lines whatever are found due to an atmosphere, in Jupiter and Saturn, besides the lines which are identical with some produced in our own atmosphere, there is one in the red, which may be caused by the presence of some unknown gas or vapour. Mars is still more peculiar, and enough is ascertained to

[p] Proc. Roy. Soc. and Phil. Trans. 1864.

discountenance the notion of his redness being due to a peculiarity of the soil[q].

To aid researches into the condition of celestial bodies, the new powers of light, discovered by Niepce, Daguerre, and Talbot, have been employed by Bond, Draper, De la Rue, and other astronomers. To our countryman, in particular, belongs the honour of successful experiments on the rose-coloured flames which extend from certain points of the sun's border during an eclipse; as well as of valuable contributions through the same agency to that enlarged survey of the physical aspect of the moon, which, since 1852, the Association has striven to promote. By another application of the same beautiful art, in connexion with clock-work, the momentary changes of magnetic force and direction, the variations of temperature, the fluctuations of atmospheric pressure, the force of the wind, the fall of rain, the proportion of ozone in the air, are registered in our observatories; and thus the inventions of Ronalds and his successors have engaged the solar rays in measuring and comparing contemporaneous phænomena of the same order over large parts of the globe—phænomena some of which are occasioned by those very rays.

As we ascend above the earth, heat, moisture, and magnetic force decrease, the velocity of wind augments, and the proportion of oxygen and nitrogen remains the same. The decrease of heat as we rise

[q] Phil. Trans. 1864.

into the air is no new subject of inquiry, nor have the views respecting it been very limited or very accordant. Leslie considered it mathematically in relation to pressure; Humboldt gave the result of a large inquiry at points on the earth's surface, unequally elevated above the sea; and finally, Mr. Glaisher and Mr. Coxwell, during many balloon ascents to the zones of life-destroying cold, far above our mountain tops, have obtained innumerable data, in all seasons of the year, through a vast range of vertical height. The result is to shew much more rapid decrease near the earth, much slower decrease at great elevations; thus agreeing in general with the view of Leslie, and yet throwing no discredit on the determinations of Humboldt, which do not refer to the free atmospheric ocean, but to the mere borders of it where it touches the earth, and is influenced thereby[s].

The proportion of carbonic acid gas in the atmosphere at great heights is not yet ascertained: it is not likely to be the same as that generally found near the earth; but its proportion may be more constant, since in those regions it is exempt from the influence of the actions and re-actions which are always in progress on the land and in the water, and do not necessarily compensate one another at every place and at every moment.

Other information bearing on the constitution of the atmosphere comes to us from the auroral beams

[s] Reports of the British Association for 1862, 1863, 1864.

and other meteoric lights known as shooting stars. For some of these objects not only appear at heights of 10, 50, and 100 or more miles above the earth, but at the height of 50 miles it is on record that shooting stars or fire-balls have left waving trains of light, whose changes of form were in seeming accordance to varying pressure in the elevated and attenuated atmosphere[t].

Researches of every kind have so enriched meteorology since our early friend, Professor J. Forbes, printed his suggestive reports on that subject; and so great have been the benefits conferred on it by the electric telegraph, that at this moment in M. Leverrier's observatory at Paris, and the office so lately presided over by Admiral FitzRoy in London, the messages are arriving from all parts of Europe to declare the present weather, and furnish grounds for reasonable expectation of the next probable change. Hardly now within the seas of Europe can a cyclone begin its career of devastation, before the warning signal is raised in our sea-ports, to restrain the too confident sailor. The gentle spirit which employed this knowledge in the cause of humanity has passed away, leaving an example of unselfish devotion, in a work which must not fail through any lack of energy on the part of this Association, the Royal Society,

[t] This is the result of a careful discussion made by myself of observations on a meteor seen from Rouen to Yorkshire, and from Cornwall to Kent, Jan. 7, 1856.

or the Government. We must extend these researches and enlarge these benefits by the aid of the telegraph bringing the ends of the world together. Soon may that thread of communication unite the two great sections of the Anglo-Saxon race, and bring and return through the broad Atlantic the happy and mutual congratulations for peace restored and friendships renewed.

The possible combinations of force by which, in the view we have been considering, the characteristic forms and special phænomena of solid, liquid, and gaseous matter are determined, may be innumerable. Practically, however, they appear to be limited, as natural products, to less than one thousand distinguishable compounds, and less than one hundred[u] elementary substances. Of these elements the most prevalent are few on the Earth; as of gases, oxygen, hydrogen, nitrogen; of solids, silicon, calcium, magnesium, sodium, iron; and it is interesting to learn by analysis of the light of stars and planets, that these substances, or some of them, are found in most of the celestial objects yet examined, and that, except in one or two instances, no other substances have been traced therein. Even the wandering meteoric stones, which fall from their courses, and are examined on the Earth, betray only well-known mineral elements, though in the manner in which these are combined, some differences appear, which

[u] At the present moment the number of 'elementary substances' is sixty-one.

by chemical research and the aid of transparent sections Professor Maskelyne and Mr. Sorby are engaged in studying and interpreting[x].

By the labours of Lavoisier and his contemporaries, Chemistry acquired a fixed logic and an accurate nomenclature. Dalton and the great physicists of the early part of this century gave that law of definite combination by proportionate weights of the elements which is for chemistry what the law of gravitation is for celestial mechanics. A great expansion of the meaning of the atomic theory took place, when Mitscherlich announced his views of isomorphous, isomeric, and dimorphous bodies. For thus it came gradually to appear that particular forces resided in crystals in virtue of their structure, lay in certain directions, and exhibited definite physical effects, if the chemical elements, without being the same, were combined in similar proportions, and aggregated into similar crystals. Some years later, ozone was discovered by Schönbein, and it concurred with a few other allotropic sub-

[x] Professor Maskelyne has made a convenient classification of the large collection of meteorites in the British Museum, under the titles of "Aërolite or Meteoric *Stone*;" "Aërosiderite or Meteoric *Iron*;" and "Aërosiderolites," which includes the intervening varieties. Mr. Sorby, whose latest results are unpublished, but will be communicated to the Royal Society, is of opinion that the substance of meteorites has undergone changes due to physical conditions in some ancient period not now to be paralleled on our planet, or on the moon, but rather to be looked for only in the immediate neighbourhood of the sun. Professor Haidinger has also made a special study of meteorites.

stances in reviving, among philosophic chemists, the inquiry as to the relative situation of the particles in a compound body, and the effects of such arrangements: an idea which had been expressed by Dalton in diagrams of atoms, and afterwards exercised the ingenuity of Exley, MacVicar, and others[y].

Everything connected with this view of the modification of physical properties by the arrangement of the particles—whether elementary or compound—is of the highest importance to Mineralogy, a branch of study by no means so much in favour even with chemists as its own merits and its collateral bearings might justly deserve. Yet it is in a great measure by help of this branch of study that the opinions now current regarding metamorphism of rocks *in situ*, and the formation of mineral veins, must acquire that solid support and general consent which at present they do not possess. Crystals, indeed, whether regarded as to their origin in nature, their fabrication by art, or their action on the rays of light, the waves of heat and sound, and the distribution of electricity, have not been neglected by the Association or its members. In one of the earliest Reports, Dr. Whewell calls attention to the state of crystallographical theory, and to

y Dalton, Chemistry, vol. i. 1808. A clear view of the simpler applications of Dalton's ideas is given by the illustrious author in Daubeny's Treatise on the Atomic Theory, 1850.

Exley, Nat. and Exp. Philosophy, 1829.

MacVicar, Reports of the British Association for 1855.

the artificial production of crystals; and in another Report, Professor Johnston notices epigene and pseudomorphous crystallization; and for many years, at almost every meeting, new and brilliant discoveries in the action of crystals on light were made known by Brewster[z], and compared with the undulatory theory by Herschel, MacCullagh, Airy, Hamilton, Whewell, Powell, Challis, Lloyd, and Stokes.

The unequal expansion of crystals by heat, in different directions, first observed by Mitscherlich, has been carefully examined in the cases of sulphate and carbonate of lime by Professor W. H. Miller[a], who has also considered their elasticity, originally measured in different relations to the axis by Savart. These and many other interesting relations of crystals have been attended to; but the Association has not yet succeeded in obtaining a complete digest of the facts and theories connected with the appearance of crystals in nature—in the fissures of rocks; in the smaller cavities of rocks; in the solid substance or liquid contents of other crystals. Such an inquiry, however, it did earnestly demand, and some steps have been taken by our own chemists, mineralogists, and geologists. But more abundant information on this class of subjects

z "Sir David Brewster must be considered as in a degree the creator of the science which studies the mutual dependence of optical properties and crystalline forms."—(Whewell, in Report on Mineralogy, Brit. Association, 1832, p. 336.)

a Rep. Proc. 1837, pp. 43, 44.

is still needed, even after the admirable contributions and recent discoveries of Bischof, Delesse, and Daubrèe[b].

Within our Association-period both the nomenclature of chemistry and the conception of the atomic theory have received not indeed a change, but such an addition to its ordinary expression as the more general language and larger meaning of Algebra have conferred on common arithmetical values. The theory of compound radicals, as these views of Liebig, Dumas, and Hofmann may be justly termed, embraces the consideration of groups of elements united in pairs by the ordinary law, these groups being for the purpose in hand treated as single elements of combination. The nomenclature which attempts in ordinary words to express these relations grows very unmanageable even in languages more easily capable of polysyllabic combinations than ours; but symbols of composition —the true language of chemistry—are no more embarrassed in the expression of these new ideas than are the mathematical symbols which deal with operations of much greater complexity on quantities more various and more variable[c]. The study of these

[b] Bischof, Chemical Geology (published by the Cavendish Society, 1856).

Delesse, Etudes sur le Métamorphisme, 1858, and other works.

Daubrèe, Sur la Relation des Sources Thermales des Plombières, avec les Filons Metallifères et la Formation des Zeolithes, 1858, and other works.

[c] On the Nomenclature of Organic Compounds, by Dr. Daubeny. Reports of British Association, 1851.

compound radicals comes in aid of experimental research into those numerous and complex substances which appear as the result of chemical transformations in organic bodies. Thus in some instances the very substances have been recomposed by art which the vital processes are every moment producing in nature; in others the steps of the process are clearly traced; in all the changes become better understood through which so great a variety of substances and structures are yielded by one circulating fluid; and the result is almost a new branch of animal and vegetable physiology, not less important for the health of mankind than essential to the progress of scientific agriculture.

The greater our progress in the study of the economy of nature, the more she unveils herself as one vast whole; one comprehensive plan; one universal rule, in a yet unexhausted series of individual peculiarities. Such is the aspect of this moving, working, living system of force and law: such it has ever been, if we rightly interpret the history of our own portion of this rich inheritance of mind, the history of that Earth from which we spring, with which so many of our thoughts are co-ordinated, and to which all but our thoughts and hopes will again return.

How should we prize this history! and exult in the thought that in our own days, within our own memories, the very foundations of the Series of Strata, deposited in the beginning of time, have been explored by our living friends, our Murchison and

Sedgwick, while the higher and more complicated parts of the structure have been minutely examined by our Lyell, Forbes, and Prestwich[c]! How instructive the history of that long series of inhabitants which received in primeval times the gift of life, and filled the land, sea, and air with rejoicing myriads, through innumerable revolutions of the planet, before in the fulness of time it pleased the Giver of all good to place man upon the Earth, and bid him look up to Heaven.

Wave succeeding wave, the forms of ancient life sweep across the ever-changing surface of the earth; revealing to us the height of the land, the depth of the sea, the quality of the air, the course of the rivers, the extent of the forest, the system of life and death—yes, the growth, decay, and death of individuals, the beginning and ending of races, of many successive races of plants and animals, in seas now dried, on sand-banks now raised into mountains, on continents now sunk beneath the waters.

Had that series a beginning? Was the earth ever uninhabited, after it became a globe turning on its axis and revolving round the sun? Was there ever a period since land and sea were separated—a period which we can trace—when the land was not shaded by plants, the ocean not alive with animals? The answer, as it comes to us from the latest observation, declares that in the lowest deposits

[c] The investigations of Murchison and Sedgwick in the Cambrian and Silurian Strata began in 1831; the views of Sir C. Lyell on Tertiary periods were made known in 1829.

of the most ancient seas in the stratified crust of the globe, the monuments of life remain. They extend to the earliest sediments of water, now in part so changed as to appear like the products of fire. What life? Only the simpler and less specially organized fabrics have as yet rewarded research among these old Laurentian rocks—only the aggregated structures of Foraminifera have been found in what, for the present at least, must be accepted as the first deposits of the oldest sea. The most ancient of all known fossils, the Eozoon Canadense of Sir W. Logan, is of this low, we may even say lowest, type of animal organization.

Then step by step we are guided through the old Cambrian and Silurian systems, rich in Trilobites and Brachiopoda, the delights of Salter and Davidson; with Agassiz and Miller and Egerton we read the history of the strange old fishes of the Devonian rocks; Brongniart, and Göppert, and Dawson, and Binney, and Hooker unveil the mystery of the mighty forests now converted to coal; Mantell and Owen and Huxley restore for us the giant reptiles of the Lias, the Oolite, and the Wealden; Edwards and Wright almost revive the beauteous corals and echinodermata; which with all the preceding tribes have come and gone before the dawn of the later periods, when fragments of mammoths and hippopotami were buried in caves and river sediments to reward the researches of Cuvier and Buckland, Prestwich and Christy, Lartet and Falconer.

And what is the latest term in this long series of successive existence? Surely the monuments of ever-advancing art—the temples whose origin is in caverns of the rocks; the cities which have taken the place of holes in the ground, or heaps of stones and timber in a lake; the ships which have outgrown the canoe, as *that* was modelled from the floating trunk of a tree, are sufficient proof of the late arrival of man upon the Earth, after it had undergone many changes and had become adapted to his physical, intellectual, and moral nature.

Compared with the periods which elapsed in the accomplishment of these changes, how short is the date of those yet standing monoliths, cromlechs, and circles of unhewn stone which are the oldest of human structures raised in Western Europe, or of those more regular fabrics which attest the early importance of the monarchs and people of Egypt, Assyria, and some parts of America! Yet tried by monuments of natural events which happened within the age of man, the human family is old enough in Western Europe to have been sheltered by caverns in the rocks, while herds of reindeer roamed in Southern France[d], and bears and hyænas were denizens of the South of England[e]. More than this, remains of the rudest human art ever seen are certainly found buried with and are thought to belong to races who lived contemporaneously with the mammoth and rhinoceros,

[d] See the Memoirs of M. Lartet on the Caves of the Dordogne, 1863–4.

[e] In the caves of Gower, Devon, and Somerset, flint flakes occur with several extinct animals.

and experienced the cold of a Gallic or British winter, from which the woolly covering of the wild animals was a fitting protection.

Our own annals begin with the Kelts, if indeed we are entitled to call by that historic name the really separate nations, Belgian, Iberian, and Teutonic, whom the Roman writers recognize as settlers in Britain[f]; settlers among a really earlier family, our rudest and oldest forefathers, who may have been, as they thought themselves to be, the primitive people of the land[g]. But beyond the Κελταί who occupied the sources of the Danube and the slopes of the Pyrenees, and were known to Rome in later days, there was present to the mind of the father of Grecian history a still more western race, the Cynetæ, who may perhaps be supposed the very earliest people of the extreme west of the continent of Europe. Were those the people, the first poor pilgrims from the East, whose footsteps we are slowly tracing in the valleys of Picardy and the south of England, if not on the borders of the lakes of Switzerland? Are their kindred still to be found among the Rhætic Alps and the Asturian cliffs, if not amid the wilds of Connemara, pressed into those mountainous recesses by the legions of Rome, the spear of the Visigoth, and the sword of the

[f] Gallic or Belgian on the south-east coast; Iberian in South Wales; German at the foot of the Grampians.—(Tacitus, Vita Agricolæ.)

[g] "Britannicæ pars interior ab iis incolitur, quos natos in insula ipsa memoria proditum dicunt."—(Cæsar, v. 12.)

Saxon? Or must we regard them as races of an earlier type, who had ceased to chip flints before the arrival of Saxon, or Goth, or Kelt, or Cynetian? These questions of romantic interest in the study of the distribution and languages of the families of man are part of a large circle of inquiry which finds sympathy in several of our sections, especially those devoted to Zoology, Physiology, and Ethnology. Let us not expect or desire for them a very quick, or, at present, a very definite settlement. Deep shadows have gathered over all the earlier ages of mankind, which perhaps still longer periods of time may not avail to remove. Yet let us not undervalue the progress of ethnological inquiry, nor fail to mark how, within the period to which our recollections cling, the revelations of early Egypt have been followed by a Chronology of the ancient kingdoms on the Tigris and Euphrates, through the same rigorous study of language. Thus has our Rawlinson added another page to the brilliant discoveries of Young and Champollion, Lepsius and Rosellini.

Nor, though obtained in a different way, must we forget the new knowledge of a people nearer home, which the philosophic mind of Keller has opened to us among his native mountains. There, on the borders of the Alpine lakes, before the great Roman general crossed the Rhone, lived a people older than the Helvetians; whose rude lives, passed in hunting and fishing, were nevertheless marked by some of the many inventions which everywhere, even in the most unfavourable situations, accompany the least civilized of mankind. Implements of stone and pottery of the rudest sort belong to the earliest of these people; while ornamented iron weapons of war, and innumerable other fabrics in that metal, appear about the later habitations, and correspond probably to the period of the true Helvetii, who quitted their home and contended with Cæsar for richer settlements in Gaul. The people of whom these are the traces on almost every lake in Switzerland are recognized as well in the ancient lake-basins of Lombardy and among the Tyrolean Alps, and farther on the north side of the mountains; and probably fresh discoveries may connect them with the country of the Sarmatians and the Scythians.

Thus at length is fairly opened, for archæology and palæontology to read, a new chapter of the world's history, which begins in the pleistocene periods of geology, and reaches to the prehistoric ages of man. Did our ancestors really contend, as the poets fancied[h], with stones and clubs against the lion and the rhinoceros, and thus expel them from their native haunts, or have they been removed by change of climate or local physical conditions? Was the existence of the hyæna and the elephant only possible in Western Europe while a climate prevailed there such as now belongs to Africa or India? and was this period of high temperature reduced in a later time for the elk, reindeer, and musk ox, which undoubtedly roamed over the hills of England and France? If we think

[h] Lucretius, v. 964–1283.

so, what a vista of long duration stretches before us, for no such changes of climate can be supposed to have occurred except as the effect of great physical changes, requiring a lapse of many thousands of years. And though we may think such changes of climate not proved, and probably careful weighing of evidence may justify our disbelief, still, if the valleys in Picardy have been excavated since the deposit of the gravel of St. Acheul[i], and the whole face of the country has been altered about the caverns of Torquay since they received remains of animals and traces of man[j]—how can we admit these facts and yet refuse the time required for their accomplishment? First, let us be sure of the facts, and especially of that main fact upon which all the argument involving immensity of time really turns, viz. the contemporaneous existence of man with the mammoth of the plains and the bear of the caverns. The remains of men are certainly *buried* with those of extinct quadrupeds; but did they *live* in the same days, or do we see relics of different periods gathered into one locality by natural processes of a later date, or confused by the operations of men?

Before replying finally to these questions, further researches of an exact kind are desirable, and the Association has given its aid towards them, both in

[i] Prestwich, Transactions of the Royal Society, 1860, and Proc. of Roy. Inst., Feb. 1864.

[j] Pengelly, Reports of the British Association, 1864.

respect to the old cavern of Kent's Hole, and the newly opened fissure of Gibraltar, from which we expect great results, though the best of our labourers has ceased from his honourable toil[k]. When these and many other researches are completed, some future Lyell, if not our own great geologist, may add some fresh chapters to the 'Antiquity of Man.'

In judging of this antiquity, in counting the centuries which may have elapsed, since smoothed flints fitted with handles of wood were used as chisels and axes by the earliest people of Scandinavia or Helvetia, and flakes of flint were employed to cleanse the skins of the reindeer in the caves of the Dordogne, or stronger tools broke up the ice in the valley of the Somme, we must be careful not to take what is the mark of low civilization for the indication of very remote time. In every country, among every race of men, such rude weapons and tools are used now, or were used formerly. On the banks of the Ohio, no less than on the English hills, mounds of earth, rude pottery, and stone weapons occur in abundance; and indicate similar wants, contrivances, customs, ideas, in different races of men living in different periods. Even when in the same country, as in Switzerland, or England, or Denmark, successive deposits of instruments of stone, bronze, or iron; successive burials of pines,

[k] The late Dr. Hugh Falconer, whose knowledge of the fossil animals of caves was remarkably exact, took a great share in these examinations.

beeches, and oaks; successively extinguished races of elephants, elks, and reindeer, give us a real scale of elapsed time, it is one of which the divisions are not yet valued in years or centuries of years.

Toward a right judgment of the length of this scale of human occupation, two other lines of evidence may be thought worthy of notice; one founded on the anatomical study of the remains of early men, the other on the laws of language. If the varieties of physical structure in man, and the deviations of language from an original type, be natural effects of time and circumstance, the length of time may be in some degree estimated by the amount of the diversities which are observed to have happened, compared with the variation which is now known to be happening. This process becomes imaginary, unless we assume all mankind to have had one local centre, and one original language. Its results must be erroneous, unless we take fully into account the superior fixity of languages which are represented in writing, and the greater tendency to diversity of every kind which must have prevailed in early times, when geographical impediments were aggravated by dissocial habits of life. It appears, however, certain that some differences of language, organization, and habits have separated men of apparently unlike races during periods longer than those which rest on historical facts[1].

Ever since the days of Aristotle, the analogy

[1] Max Müller on the Science of Language.

existing among all parts of the animal kingdom, and in a general sense we may say among all the forms of life, has become more and more the subject of special study. Related as all living beings are to the element in which they move and breathe, to the mechanical energies of nature which they employ or resist, and to the molecular forces which penetrate and transform them, some general conformity of structure, some frequently recurring resemblance of function, must be present, and cannot be overlooked. In the several classes this analogy grows stronger, and in the subdivisions of these classes real family affinity is recognised. In the smallest divisions which have this family relation in the highest degree, there seems to be a line which circumscribes each group, within which variations occur, from food, exercise, climate, and transmitted peculiarities. Often one specific group approaches another, or several others, and a question arises whether, though now distinct, or rather distinguishable, they always have been so from their beginning, or will be always so until their disappearance.

Whether what we call species are so many original creations or derivations from a few types or one type, is discussed at length in the elegant treatise of Darwin[m], himself a naturalist of eminent rank. It had been often discussed before. Nor will any one think lightly of such inquiries, who remembers the essay of Linnæus, "De Telluris orbis incremento,"

[m] On the Origin of Species, 1859.

or the investigations of Brown, Prichard, Forbes, Agassiz, and Hooker regarding the local origin of different species, genera, and families of plants and animals, both on the land and in the sea. Still less will he be disposed to undervalue its importance, when he reflects on the many successive races of living forms more or less resembling our existing quadrupeds, reptiles, fishes, and mollusca, which appear to have occupied definite and different parts of the depths of ancient time; as now the tiger and the jaguar, the cayman and the gavial, live on different parts of the terrestrial surface. Is the living elephant of Ceylon the lineal descendant of that mammoth which roamed over Siberia and Europe, and North America, or of one of those sub-Himalayan tribes which Dr. Falconer has made known, or was it a species dwelling only in circumpolar regions? Can our domestic cattle, horses and dogs, our beasts of chace and our beasts of prey, be traced back to their source in older types, contemporaries of the urus, megaceros, and hyæna on the plains of Europe? If so, what range of variation in structure does it indicate? if not so, by what characters are the living races separated from those of earlier date?

Specific questions of this kind must be answered, before the general proposition, that the forms of life are indefinitely variable with time and circumstance, can be even examined by the light of adequate evidence. That such evidence will be gathered and rightly interpreted, I for one neither doubt nor fear;

nor will any be too hasty in adopting extreme opinions or too fearful of the final result, who remember how often that which is true has been found very different from that which was plausible, and how often out of the nettles of danger we have plucked the flowers of safety. At the present moment the three propositions which were ever present to the mind of Edward Forbes may be successfully maintained, as agreeing with many observed phænomena; and around them as a basis of classification may be gathered most of the facts and most of the speculations which relate to the history of life[n]. First, it may be admitted that plants and animals form many natural groups, the members of which have several common characters, and are parted from other groups by a real boundary line, or rather unoccupied space. Next, that each of these groups has a limited distribution in space, often restrained by high mountains or deep seas, or parallels of temperature, within which it has been brought into being. Thirdly, that each group has been submitted to, or is now undergoing, the pressure of a general law, by which its duration is limited in geological time; the same group never reappearing after being removed from the series.

How important, in the view of this and many other questions, is that never-tiring spirit of geographical and maritime discovery, to which through four

[n] See the remarkable Essay of E. Forbes on the distribution of the existing Fauna and Flora of the British Isles, in Memoirs of Geol. Survey of Britain, vol. i. p. 336.

hundred years Europe has sent her noblest sons and her most famous expeditions; sent them, alas! too often to an early grave. Alas! for Franklin, who carried the magnetic flag into the Icy Sea from which he had already brought trophies to Science! Alas! for Speke, who came home with honour from the head waters of the Nile! Forgotten they can never be, whenever on occasions like this, we mourn the absence of our bravest and our best; praise, never-ending praise be theirs, while men retain the generous impulse which prompts them to enterprises worthy of their country and beneficial to mankind!

Ἀεὶ σφῶν κλέος ἔσσεται κατ' αἶαν.

If it be asked, what share in the discoveries and inventions of the last thirty-three years is claimed for the British Association; let us answer fearlessly—We had a part in all. In some of them we took the foremost place by the frequency of our discussions, the urgency of our recommendations, the employment of our influence, and the grant of our funds. For others we gave all our strength, to support the Royal Society and other Institutions in their efforts to accomplish purposes which we approve. In all instances our elastic system responds quickly to pressure, and returns the friendly impulse. If we look back on the work of previous years, it is easy to mark the special action of the Association in fields which hardly could be entered by any other adventurers.

Many of the most valuable labours of which we are now reaping the fruits, were undertaken in consequence of the reports on special branches of Science which appear in the early volumes of our Transactions—reports in which particular data were requested for confirming or correcting known generalizations, or for establishing new ones. Thus a passage in Professor Airy's report on Physical Astronomy [o] first turned the attention of Adams to the mathematical vision of Neptune; Lubbock's Report on Tides [p] came before the experimental researches and reductions, which since 1834 have so often engaged the attention of Whewell and Airy and Haughton, with results so valuable and so suggestive of further undertakings. Among these results may be placed additional knowledge of the probable depth of the channels of the sea. For before the desire of telegraphic communication with America had caused the bed of the North Atlantic to be explored by soundings to a depth seldom exceeding three miles, there was reason to conclude from the investigations of Whewell on Cotidal Lines [q] that a depth of nine miles was attained in the South Atlantic, and from the separate computations of Airy and Haughton that a somewhat greater depth occurred in a part of

[o] Reports of the British Association for 1832, p. 154. Laplace had indeed observed that "the planet Uranus and his satellites, lately discovered, give reason to suspect the existence of some planets not yet observed;" thereby encouraging the search for new discoveries in our own system. (Exp. du Syst. du Monde, 1799, 4to. p. 350.)

[p] Reports of the British Association, 1832.

[q] Trans. of Roy. Soc. 1833.

the course of the tide-wave which washes the coast of Ireland [r]. The greater portion of the sea-bed is within reach of soundings directed by the superior skill and greater perseverance of modern scientific navigators; a depth of six miles is said to have been reached in one small tract of the North Atlantic; depths of nine or ten miles in the deepest channels of the sea are probable from considering the general proportion which is likely to obtain between sea-depths and mountain-tops. Thus the data are gradually being collected for a complete survey of the bed of the sea, including among other things information, at least, concerning the distribution of animal and vegetable life beneath the waters.

Waves—their origin, the mechanism of their motion, their velocity, their elevation, the resistance they offer to vessels of given form, these subjects have been firmly kept in view by the Association, since first Professor Challis [s] reported on the mathematical problems they suggest, and Sir J. Robison and Mr. Scott Russell undertook to study them experimentally [t]. Out of this inquiry has come a better knowledge of the forms which ought to be given to the 'lines' of ships, followed by swifter passages across the sea, both by sailing vessels and steamers, of larger size and greater lengths than were ever tried before [u].

[r] Trans. of Roy. Irish Acad. 1855.

[s] Reports of the British Association, 1833, 1836.

[t] Ibid. 1837 and following years.

[u] Ibid. 1840—1843.

One of the earliest subjects to acquire importance in our thoughts, was the unexplored region of meteorology laid open in Professor J. Forbes' Reports [x]. Several of the points to which he called attention have been successfully attained. The admirable instruments of Whewell, Osler, and Robinson have replaced the older and ruder anemometers; and are everywhere in full operation, to record the momentary variations of pressure, or sum the varying velocities of the wind. No small thanks were due to Mr. Marshall and Mr. Miller [y] for their enterprise and perseverance, in placing rain guages and thermometers amidst the peaks of Cumberland and Westmoreland. These experiments are now renewed in both counties and in North Wales; and I hope to hear of similar efforts among the mountains of the West of Ireland and the West of Scotland. Our meteorological instruments of every kind have been improved; our system of photographic registration has spread from Kew into other observatories; and our corresponding member, Professor Dovè, has collected into systematic maps and tables the lines and figures, which represent annual and monthly climate over every land and sea.

In the same manner, by no sudden impulse or accidental circumstance, rose to its high importance

[x] Reports of the British Association, 1832—1840.

[y] Mr. Marshall's observations were made in Patterdale, Mr. Miller's about Wastdale Head. (British Association Reports for 1846, and Royal Society's Transactions, 1850.)

that great system of magnetic observations, on which for more than a quarter of a century the British Association and the Royal Society, acting in concert, have been intent. First, we had Reports on the mathematical theory and experimental researches of magnetism by Christie, 1833, Whewell, 1835, and Sabine, 1835:—afterwards, a magnetic survey of the British Islands[z]; then, the establishment of a complete observatory at Dublin, with newly arranged instruments, by Dr. Lloyd, in 1838. On all this gathered experience we founded a memorial to Her Majesty's government, made a grant of £400 from our funds for preliminary expenses, and presented to the meeting of this Association in Birmingham, in 1839, a Report of progress, signed by Herschel and Lloyd. From that time how great the labour, how inestimable the fruits! Ross sails to the magnetic pole of the south; America and Russia cooperate with our observers at Kew, Toronto, and St. Helena; and General Sabine, by combining all this united labour, has the happiness of seeing results established of which no man dreamed—laws of harmonious variation affecting the magnetic elements of the globe, in definite relation to the earth's movement, the position of the sun and moon, the distribu-

[z] The survey was begun in Ireland in 1835, by Lloyd, Sabine, and Ross; and completed in England, Wales, and Scotland in 1837, by the same magneticians, assisted by Fox and Phillips. It was repeated in 1857 and following years by Sabine, Lloyd, Welsh, Haughton, Galbraith, and Stoney.

tion of temperature, and the situation in latitude and longitude[a].

Our efforts have not been fruitless, whether with Mr. Mallet we make experiments on artificial earth-shocks at Dalkey, or survey the devastations round Vesuvius, or tabulate the records of earthquakes since the beginning of history[b]; or establish the Kew Observatory as a scientific workshop where new instruments of research are made and proved and set to work[c]; or dredge the sea with Forbes, and Brady, and Jeffreys[d]; or catalogue the stars with Baily[e]; or investigate electricity with Harris, Ronalds, Thomson, and Jenkin[f]; or try the action of long-continued heat with Harcourt[g]: in these and a hundred other directions, our attempts to gain knowledge have brought back new facts and new laws of phænomena, or better instruments for attaining or better methods for interpreting them. Even when we enter the

[a] Trans. of the Royal Society for many years; Reports of the British Association, 1840 and following years; Rede Lecture, 1862.

[b] British Association Reports; Experiments at Dalkey, 1853; Report on Earthquakes, 1840–1858. See also the excellent communications of M. Perrey to the Memoirs of the Academy of Dijon.

[c] The Kew Observatory became a part of the system of the Association in 1842.

[d] See Reports of the Dredging Committees from 1842 to 1864; Nat. Hist. Trans. of Northumberland and Durham; Jeffreys' British Conchology.

[e] British Association Catalogue of Stars, 1845.

[f] The latest result of these researches is an instrumental standard of electrical resistance. (Reports of the British Association, 1863–1864.)

[g] Reports of the British Association, 1846–1860.

domain of practical art, and apply scientific methods to test a great process of manufacture, we do not fail of success; because we are able to join in united exertion the laborious cultivators of science and the scientific employers of labour.

Am I asked to give an example? Let it be Iron, the one substance by the possession of which, by the true knowledge and right use of which, more than by any other thing, our national greatness is supported. What are the ores of iron—what the peculiarities and improvements of the smelting processes—what the quality of the iron—its chemical composition—its strength in columns and girders as cast-iron; in rails and boiler plate, in tubes and chains, as wrought iron—what are the best forms in which to employ it, the best methods of preserving it from decay;—these and many other questions are answered by many special Reports in our volumes, bearing the names of Barlow, Mallet, Porter, Fairbairn, Bunsen, Playfair, Percy, Budd, Hodgkinson, Thomson; and very numerous other communications from Lucas, Fairbairn, Cooper, Nicholson, Price, Crane, Hartley, Davy, Mushet, Hawkes, Penny, Scoresby, Dawes, Calvert, Clark, Cox, Hodgkinson, May, Schafhaeutl, Johnston, Clay, and Boutigny. Beyond a question, a reader of such of these valuable documents as relate to the strength of iron, in its various forms, would be far better informed of the right course to be followed in experiments on armour-plated ships and forts to resist assault, and in the construction of ordnance to attack them, than he is likely to be from merely witnessing a thousand trials of the cannon against the target. Anyone who remembers what the iron furnace was forty years ago, and knows its present power of work; or who contrasts the rolling mills and hammers of other days, with the beautiful machines, which now, with the gentlest motion but irresistible force, compel the strong metal to take up the most delicately moulded form; will acknowledge, that within the period since the British Association began to set itself to the task of reconciling the separated powers of Theory and Experience, there has been a total change in the aspect of each, to the great advantage of both.

Our undertakings have not been fruitless. We attempted what we had well considered, and had the power to accomplish; and we had the more than willing help of competent persons of our own body, the friendly aid of other Institutions, and the sanction of the Government, convinced of the sincerity of our purpose and the wisdom of our recommendations.

The same work is ever before us; the same prudence is always necessary; the same aid is always ready. Great indeed should be our happiness, in reflecting on the many occasions, when the Royal Society in particular, and other Institutions older than our own, have readily placed themselves by our side, to share our responsibility and diminish our difficulties. But for this, our wishes might not always have prevailed; and the horizon of science would not have been so clear as now it is. Of late years indeed, Societies formed on our model have taken up special parts of our work ; and thus to some extent have relieved us of the pressure of communications relating to the practice of particular professions and the progress of some public questions. Not that scientific agriculture, social statistics, or physiology are neglected in our meetings, but that these and other practical subjects are found to have more than one aspect, and to require more than one mode of treatment. With us, facts well ascertained, conclusions rightly drawn, will ever be welcome, from whatever quarter of the horizon of science they make their appearance. Whatever societies cultivate these objects, they are our allies, and we will help them, if we may. With pleasure we receive proofs of the good work done in limited districts by the many admirable Field Clubs formed by our countrymen; whether, like those of Tyne-side and the Cotswolds, and in this immediate vicinity those of Warwickshire, Worcestershire, and Dudley, they explore the minutest recesses of our hills and glens ; or, like the rangers of the Alps, bring us new facts regarding glaciers, ancient climate, and altered levels of land and sea.

By these agreeable gatherings natural history is most favourably commended ; and in the activity and enlarged views of the officers who conduct them, the British Association recognises the qualities, by which the vitality of scientific research is maintained, and its benefits diffused among the provincial Institutions of the Empire.

Such, Gentlemen, are some of the thoughts which fill the minds of those, who, like our Brewster, and Harcourt, and Forbes, and Murchison, and Daubeny, stood, anxious but hopeful, by the cradle of this British Association; and who now meet to judge of its strength, and measure its progress. When, more than thirty years ago, this Parliament of Science came into being, its first child-language was employed to ask questions of Nature; now, in riper years, it founds on the answers received further and more definite inquiries directed to the same prolific source of useful knowledge. Of researches in science completed, in progress, or in beginning, each of our annual volumes contains some three hundred or more passing notices, or full and permanent records. This digest and monument of our labours is indeed in some respects incomplete, since it does not always contain the narrative or the result of undertakings which we started, or fostered, or sustained; and I own to having experienced on this account once or twice a feeling of regret. But the regret was soon lost in the gratification of knowing, that other and equally beneficial channels of publication had been found; and that by these examples it was proved how truly the Association kept to the real purpose of its foundation, "the Advancement of Science," and how heartily it rejoiced in this advancement without looking too closely to its own share in the triumph. Here, indeed, is the stronghold of the British Association. Wherever and by whatever means sound learning and useful knowledge are advanced, there to us are friends. Whoever is privileged to step beyond his fellows on the road of scientific discovery, will receive our applause, and, if need be, our help. Welcoming and joining in the labour of all, we shall keep our place among those who clear the roads and remove the obstacles from the paths of science; and whatever be our own success in the rich fields which lie before us, however little we may now know, we shall prove, that in this our day we knew at least the value of knowledge, and joined hearts and hands in the endeavour to promote it.